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(54) Title: METHOD FOR BENDING AND TEMPERING GLASS SHEETS			
(57) Abstract			
<p>The invention relates to a method for bending and tempering glass sheets, particularly automotive backlights and side windows. A glass sheet supported by a ring mould (6) is heated and bent gravitationally close to a correct shape. In a bending station (17) the glass sheet is pressed to its final shape by means of an overhead, non-contacting full-face mould, provided with a double channeling for blasting and vacuuming. The vacuum of a mould (15) is used to lift a bent glass sheet up from ring mould (6) and the glass sheet is heated for equalizing temperature differences and for increasing the temperature to a tempering temperature. Below the glass sheet is brought a tempering frame (8), upon which the glass is lowered from the full-face mould and which is used for carrying the glass to tempering.</p>			

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Method for bending and tempering glass sheets

The present invention relates to a method for bending and tempering glass sheets, particularly automotive backlights and side windows, wherein a glass sheet supported by a ring mould is heated to a bending temperature and the glass sheet is allowed to bend gravitationally close to a correct bending shape.

Less complicated bending shapes are obtained by the application of gravitational bending. On the other hand, the production of more complicated bending shapes requires the use of a full-face or partial-face mould at least above a glass sheet in addition to a ring mould. If the overhead mould is in contact with glass or only provided with blasting orifices, there is generally also required a lower mould for preventing the uncontrolled downward bending of the unsupported sections of a glass sheet. Problems occur especially when the temperature of a glass sheet bent to its final shape is desired to be maintained sufficiently high or to increase it to a sufficient level for tempering. When using conventional bending mould technique, a glass sheet tends to cool to some extent during the course of bending. The increase of temperature after a bending operation involves the problem of how to retain a desired bending shape while one surface of a glass sheet is free for applying the heating effect to a glass sheet. In those solutions, wherein the heating of a glass sheet is effected on top of horizontal conveyor rolls prior to advancing the glass sheet to bending mould equipment, a problem is the positioning of a glass sheet between the transfers. This positioning problem does not occur if a glass sheet is already positioned prior to a heating operation directly onto a ring mould.

An object of the invention is to provide a method for bending and tempering glass sheets in a manner that the bent shape of a glass sheet can be retained and controlled even as the temperature of a bent glass sheet is equalized and if necessary heated to a sufficient temperature for tempering.

This object is achieved by means of the invention on the basis of the characterizing features set forth in the annexed claim 1.

One embodiment of the invention will now be described in more detail with reference made to the accompanying drawing, showing a schematic vertical section of an apparatus for carrying out a method of the invention.

A corresponding furnace assembly has been described in the Applicant's earlier European Patent publications 0132701 and 0370313, incorporated herein as reference in terms of the general operating principles and structural details of such apparatus.

In loading, a glass sheet is placed and simultaneously properly positioned upon a ring mould 6 in a loading station, located at the inlet end of an upper conveyor track 1. Moulds 6 are carried in wagons 3 whose front walls 4 separate successive preheating stations 5 from each other. Between the stations there may also be a gate, which is opened and closed. Wagons 3, 4 are advanced by one wagon length at a time on track 1. Thus, a piece of glass 7 placed upon ring mould 6 is sequentially carried through preheating and pre-bending stations 5. In the first pre-bending stations, the glass is heated with electric resistances and possibly also by

glass. The hot air is aspirated through openings 12 included in the lower furnace section and blasted into stations 5 through orifices 13. If necessary, it is possible to employ heaters for heating the blasting air.

In the final station 5' a glass sheet 7 is heated with electric resistance elements 14 to a temperature sufficient for achieving gravitational pre-bending close to a final bending shape. Following a pre-bending operation, the glass is carried into a bending station 17 located at the outlet end of a furnace, wherein a glass sheet supported by ring mould 6 is approached by an overhead full-face mould 15, the shape of whose surface 16 substantially corresponds to a desired final bending shape. It is possibly necessary to anticipate the bending occurring during transfers and, thus, the surface shape of mould 15 is slightly "short". Mould 15 is double-channeled in a manner that the orifices in its surface can be simultaneously used for blasting and aspiration. The operation and manufacturing technique of such a mould have been described in detail in the Applicant's earlier published European Patent applications EP-0448959 and EP-

The blasting power of mould 15 is adjusted to exceed the aspirating power for producing between the mould and the glass sheet a positive pressure for pressing the glass sheet to its final bending shape. Thus, this bending is effected without contacting the top surface of a glass sheet. After a bending operation, the aspirating power is increased in relation to blasting power and a bent glass sheet is lifted by means of the aspiration or suction of said overhead press bending mould 15 away from ring mould 6. Wagon 3, along with its ring mould 6, is lowered down by means of a hoist 10 and it returns along track 2 through the bottom of a furnace to the inlet end into the loading station by lifting it there by means of a

hoist 11. Unlike the embodiment shown in the drawing, it may be preferable that wagon 3, along with its mould 6, be first carried backwards in its traveling direction and only then lowered down. Thus, a bent glass sheet can be heated from below by means of fixed heating elements while the glass sheet is supported by the overhead full-face mould 15. Another possibility is to effect the equalization of temperature exclusively by means of air circulated through the mould.

The full mould 15 is ceramic and the shape of its surface 16 corresponds substantially to the final bending shape of glass 7. Inside the full mould there is a double manifold, opening to surface 16 with nozzle orifices for producing on the glass surface both vacuum and blasting. When a glass sheet is retained as supported by full mould 15 with a negative pressure, the glass reaches and retains precisely its final shape. With the most complicated shapes, wherein the vacuum of overhead full mould 15 is not sufficient to achieve a final shape, a further pressing is effected from below by means of a lower partial or full-face mould or by means of a combination of a frame piece and its associated press, whereby the outermost edge of glass is pressed against overhead full mould 15.

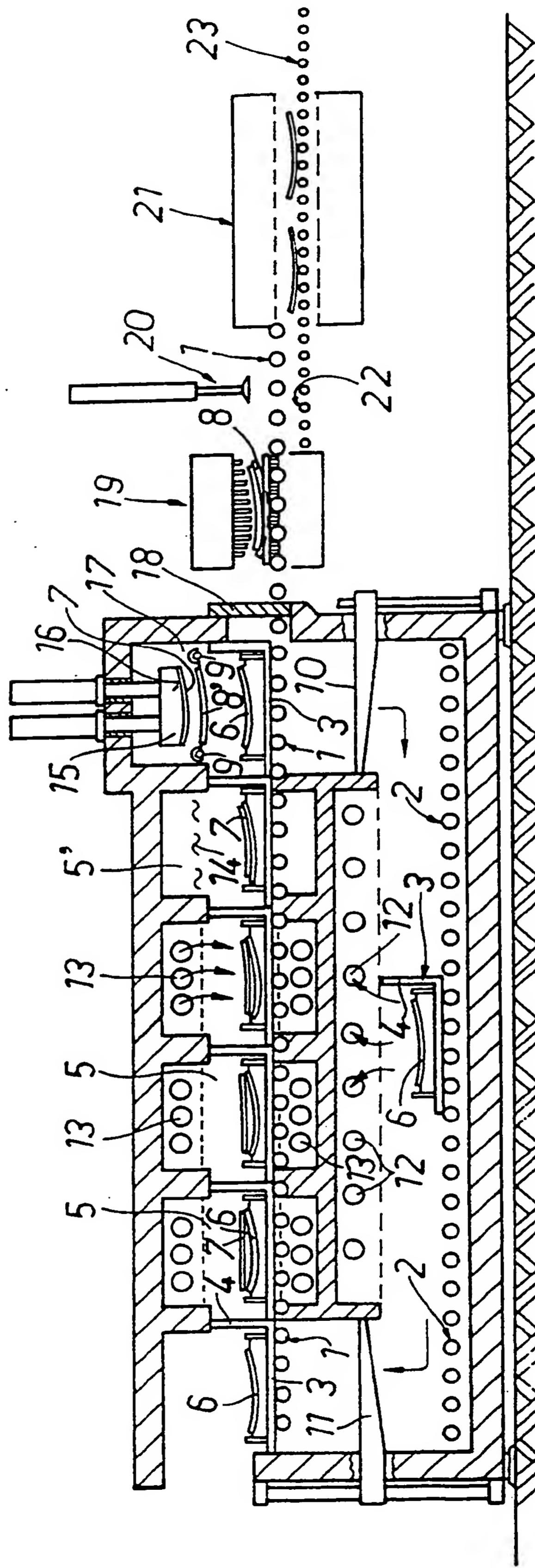
While a glass sheet is supported by means of the vacuum of full mould 15, it can be simultaneously heated from below by blasting hot air to the bottom surface of glass. The purpose of blasting is to equalize temperature differences in glass and to heat it to a tempering temperature. Instead of and in addition to hot-air blasting, it is possible to employ lower heating resistances. The heat tempering can also be effected by using hot air blasted through the blasting orifices of mould 15.

It is also possible to employ such heating devices which can be shifted aside from below said mould 15, so that a glass sheet 7 can be lifted and lowered by means of a vertically movable mould. Therefore, a station 17 can be provided with horizontal guides 9 that can also be used for manipulating a special tempering frame 8' between station 17 and an external tempering station. When the heating devices have been shifted onto the side of station 17, either said tempering frame 8' along guides 9 or said tempering frame 8 along track 1 is brought to a position below said mould 15. For a tempering operation, a heated piece of glass 7 is shifted from full mould 15 onto tempering frame 8' or 8 brought therebelow. The tempering frame 8' can be intended e.g. for side windows and the tempering frame 8 for backlights. The tempering frame 8 is used to carry the glass quickly to a chiller 19. The tempered piece of glass is lifted from tempering frame 8 by means of an overhead pick-up 20 onto a roll conveyor 22, from which the glass travels through an after-cooler 21 to an unloading station 23.

The invention is not limited to the above-described embodiment but many details can be modified within the scope of the annexed claims. Thus, for example, a stationary mould 15 can be adapted to approach the glass 7 by lifting said wagon 3 by means of hoist 10. It is also possible that heat tempering is effected in a heat-tempering station arranged between stations 17 and 19, whereby said mould 15 must be made horizontally movable between bending station 17 and the heat-tempering station. In this case, as well, the heating elements (e.g. lower resistances) can be stationary in position. If the heat tempering is only effected by the hot-air blasting of mould 15, no separate heat-tempering station or movable heating elements are required.

Claims

1. A method for bending and tempering glass sheets, such as vehicle glazings, particularly automotive backlights and side windows, in which method a glass sheet (7) supported by a ring mould (6) is heated to a bending temperature and the glass sheet is allowed to bend gravitationally close to a correct bending shape, characterized in that after a bending operation the temperature differences in glass are equalized while said glass sheet (7) is supported from above and at least partially carried by an overhead, non-contacting mould (15).
2. A method as set forth in claim 1, characterized in that during the course of bending the blasting power of said overhead mould (15) is adjusted to exceed the vacuum power so as to produce between a surface (16) and glass sheet (7) a positive pressure for pressing the glass sheet to its final bending shape.
3. A method as set forth in claim 1 or 2, characterized in that after a bending operation the glass sheet is supported by means of an overhead press-bending mould (15) and the glass sheet is heated while it is supported by said overhead press-bending mould (15).
4. A method as set forth in any of claims 1-3, characterized in that said glass sheet (7) bent in bending station (17) is lifted and lowered by means of an overhead, non-contacting full-face mould (15, 16).



INTERNATIONAL SEARCH REPORT

International Application No PCT/FI 92/00257

I. CLASSIFICATION OF SUBJECT MATTER (If several classification symbols apply, indicate all)⁶

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: C 03 B 23/035

II. FIELDS SEARCHED

Minimum Documentation Searched⁷

Classification System	Classification Symbols
IPC5	C 03 B

Documentation Searched other than Minimum Documentation
to the Extent that such Documents are Included in Fields Searched⁸

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT⁹

Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
A	EP, A1, 0183418 (GLASSTECH, INC.) 4 June 1986, see the whole document --	1-4
P,A	EP, A1, 0448959 (TAMGLASS OY) 2 October 1991, cited in the description -----	1-4

^{*} Special categories of cited documents:¹⁰

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IV. CERTIFICATION

Date of the Actual Completion of the International Search

17th November 1992

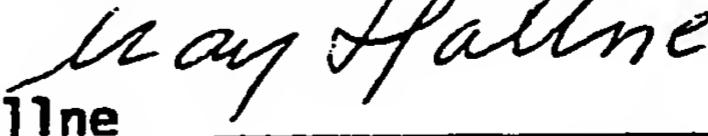
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May Hallne

Form PCT/ISA/210 (second sheet) (January 1985)

**ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.PCT/FI 92/00257**

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on **30/10/92**.
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A1- 0183418	86-06-04	AU-B-	563681	87-07-16
		AU-D-	4998785	86-05-29
		JP-C-	1557988	90-05-16
		JP-A-	61132529	86-06-20
		US-A-	4575390	86-03-11
		US-A-	4609391	86-09-02
EP-A1- 0448959	91-10-02	JP-A-	4224123	92-08-13
		US-A-	5066320	91-11-19

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